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**GEAR BEARING FOR A STEERING WHEEL POSITION SENSOR**

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**TECHNICAL FIELD**

The present invention relates to steering wheel position sensors, also referred to as absolute handwheel position sensors (AHPS).

10 **BACKGROUND OF THE INVENTION**

Steering wheel position sensors are used in automotive applications for electronic monitoring of steering functions of a motor vehicle. An example of a current steering wheel position sensor of Delphi of Troy, MI, which is depicted at Figures 1 through 5.

15 Delphi's conventional steering wheel position sensor 10 uses non-contacting Hall effect sensor technology, producing dual outputs of indication of steering wheel rotation: a coarse output and a fine output. The conventional steering wheel sensor 10 is designed for electronic control systems requiring steering wheel position input. Typical applications of the  
20 conventional steering wheel position sensor 10 include, for example, chassis controlled stability enhancement systems, electrically assisted power steering, steer-by-wire systems and navigation systems.

As shown at Figures 1 and 2, the conventional steering wheel position sensor 10 includes a housing 14 having a mounting hole 16. The  
25 conventional steering wheel position sensor 10 is mounted to the steering column 12 (shown at Figure 1) via the steering column passing through an engagement aperture 20 of a large main gear 22, wherein the hole 16 and the engagement aperture 20 are concentrically aligned with each other. When the steering wheel of the motor vehicle is turned, the steering column 12 rotates the  
30 main gear 22 inside the housing 14. The main gear 22 has teeth 22a which rotatably drive a small auxiliary gear 24 via its respective teeth 24a enmeshed

therewith. Both of the main and auxiliary gears 22, 24 are composed of DELRIN 100 (DELRIN is a registered trademark of DuPont for an acetal resin material), and each respectively therewithin contain an annular permanent magnet 26a, 26b (see Figure 5). Two linear Hall effect sensors 28a, 28b sense magnetic field rotation of the main gear 22. A pair linear Hall sensors, arranged perpendicularly relative to each other 28c, 28d (shown best at Figure 4), sense the magnetic field rotation of the auxiliary gear 24. Signals from all four sensors 28a, 28b, 28c, 28d are acquired by a microcontroller 30 and processed to find the instantaneous angle of rotation of the steering column 12. This angle is then used to set the values of the duty cycle for both pulse width-modulated outputs. The microcontroller 30 simultaneously produces two pulse width-modulated outputs based on the values previously set: one output with coarse resolution and a second output with fine resolution, which appear, via suitable wiring, at wires emanating from an electrical connector 18.

As can be understood by reference to Figures 3 through 5, the auxiliary gear 24 has an annular lip 24b and an annular base 24c connected to the annular lip (see Figure 5). The auxiliary gear 24 is rotatably interfaced with a ring shield 32 in the form of an annular ring shield wall 32a which confines the magnetic field of the auxiliary gear. The ring shield 32 provides a gear bearing 34 for the auxiliary gear 24 at two locations of guidance for the auxiliary gear, an upper guide surface 34u at the top surface of the ring shield wall which slidingly abuts the annular lip 24b and an inner guide surface 34i of the inside surface of the ring shield wall which slidingly abuts the annular base 24c. Both of the guide surfaces 34u, 34i involve sliding friction at the aforesaid abutments with the auxiliary gear 24. Further, the annular magnet 26b of the auxiliary gear 24 tends to attract the ring shield 32, causing frictional effects (ie., wear, heat, vibration, noise, back lash, etc.) between the auxiliary gear and the upper and inner guide surfaces 34u, 34i to be enhanced.

While the conventional steering wheel position sensor 10 performs quite admirably, it would be desirable, if somehow possible, to

eliminate the frictional effects which occur between the auxiliary gear and the ring shield.

#### SUMMARY OF THE INVENTION

5                   The present invention is an improved conventional steering wheel position sensor in which the improvement lies in elimination of frictional effects between the auxiliary gear and the ring shield.

                  The improved steering wheel position sensor according to the present invention has all components as hereinbefore described with respect to  
10   Delphi's conventional steering wheel position sensor, including the holed housing and apertured main gear, wherein only the environs of the auxiliary gear are now modified.

                  The auxiliary gear is provided with a centrally disposed axle hole. Additionally, while the annular base remains connected thereto, an annular lip is  
15   now absent.

                  The ring shield is modified, wherein the ring shield wall height adjacent the main gear is similar to that of the above described conventional ring shield wall; however, distally from the main gear, the height of the ring shield is increased to a height above the auxiliary gear and is covered by a truncated plate,  
20   the truncation coinciding with the height change of the ring shield wall adjacent the main gear. The truncated plate is dimensioned relative to the ring shield such that an axle connected with the truncated plate is disposed at the axial center of the ring shield. The axle is connected to the truncated plate in perpendicular relation thereto.

25                   An improved auxiliary gear bearing according to the present invention resides in the axle being received by the axle hole, and a head of the axle holding, in freely rotatable fashion, the auxiliary gear relative to the ring shield.

                  As a consequence of the aforesaid modification, the auxiliary gear is able to rotate on the axle without any frictional engagement with the ring shield, the  
30   only contact being at the bearing afforded by the axle. This structural

improvement results in the elimination of frictional effects occasioned by the former use of the upper and inner guide surfaces, both of which being now obviated.

Accordingly, it is an object of the present invention to provide an improved axle mounting for the auxiliary gear of a conventional steering wheel position sensor which obviates upper and inner ring shield bearing surfaces.

This and additional objects, features and advantages of the present invention will become clearer from the following specification of a preferred embodiment.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a prior art steering wheel position sensor, also known as an absolute handwheel position sensor (AHPS), manufactured by Delphi Automotive Systems, Troy, MI, shown in operation.

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Figure 2 is an exploded, perspective view of the prior art steering wheel position sensor of Figure 1.

Figure 3 is a perspective interior view of the prior art steering wheel position sensor of Figure 1, showing in particular the main and auxiliary gears thereof.

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Figure 4 is a perspective interior view as in Figure 3, wherein now the auxiliary gear has been removed to show a ring shield thereof.

Figure 5 is a partly sectional, perspective side view of the prior art steering wheel position sensor of Figure 1.

Figure 6 is an exploded, perspective view of the steering wheel position sensor according to the present invention.

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Figure 7 is a perspective interior view of the improved steering wheel position sensor according to the present invention.

Figure 8 is a detail, partly sectional, perspective side view of the improved steering wheel position sensor of Figure 6, showing in particular the auxiliary gear and its bearing.

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Figure 9 is a partly sectional perspective side view of the improved steering wheel position sensor of Figure 6.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

5 Referring now to the Drawing, Figures 6 through 9 depict an improved steering wheel position sensor 100 according to the present invention. In this regard, all components identical with those of the aforescribed conventional steering wheel position sensor 10 will be labeled in Figures 6 through 9 using the same numerals, wherein a further elaboration of the structure and function thereof is unnecessary for the sake of brevity, and  
10 wherein parts of modified components will be designated by the same numerals of the conventional steering wheel position sensor 10 now with a prime.

The improved steering wheel position sensor 100 according to the present invention has all components as hereinabove described with respect  
15 to Delphi's conventional steering wheel position sensor 10, including the housing 14 with its mounting hole 16, main gear 22 with its engagement aperture 20, and the sensing electronics, wherein only the environs of the auxiliary gear 24' are now modified to provide an improved auxiliary gear bearing 102 therefor (see Figure 8) according to the present invention.

20 The auxiliary gear 24' has teeth 24a' enmeshed with the teeth 22a of the main gear 22, and is provided with a centrally disposed axle hole 104. An annular base 24c' is connected thereto (the annular lip described hereinabove with respect to the conventional steering wheel position sensor 10 is not present). The auxiliary gear 24' further includes therewithin an annular magnet  
25 26b'.

The ring shield 32' is modified from that of the conventional steering wheel position sensor 10, wherein the ring shield wall 32a' now includes a low rise portion 32L adjacent the main gear 22 and a high rise portion 32H distally spaced from the main gear.

30 The low rise portion 32L of the ring shield wall 32a' has a height similar to that of the above described conventional ring shield wall adjacent the

main gear 22 (encompassing the area circumscribed by the meshing of the teeth 22a, 24a'). In this regard, the height  $H_1$  of the ring shield wall 32a' at the low rise portion 32L is such that the upper surface 32u is below the height of the teeth 24a' of the auxiliary gear 24', whereby the enmeshed teeth 22a, 24a' are  
 5 free of, and unencumbered by, the low rise portion of the ring shield wall.

Distally from the main gear 22 is the high rise portion 32H of the ring shield wall 32a', wherein the height  $H_2$  thereof rises above the auxiliary gear 24'. A wall edge 32e defines the demarcation between the low and high rise portions 32L, 32H of the ring shield wall 32a'.

10 A truncated plate 106 is connected (preferably integrally) with the high rise portion 32H, wherein the truncation edge 106e coincides with the wall edge 32e. The truncated plate 106 occupies (per the depicted embodiment) over fifty percent of the area of the ring shield 32', wherein the truncated plate 106 overlies the axial center of the ring shield.

15 An axle 108 is connected to the truncated plate 106 at the axial center of the ring shield 32'. The axle 108 projects downwardly in perpendicular relation to the truncated plate 106.

The improved auxiliary gear bearing 102 is provided by the axle 108 being received by the axle hole 104. The axle is held fixed relative to the truncated plate, as for example by the axle, after having passed through the axle hole 104 and through a hole in the truncated plate, being then spread into a press fit with the truncated plate by application of a punch axially upon the end of the axle. A head 108h of the axle 108 holds, in freely rotatable relation, the  
 20 auxiliary gear 24' relative to the ring shield 32'.

25 The dimensions of the ring shield wall 32a' and the annular base 24c' are such that the annular base does not contact the ring shield wall when the auxiliary gear is mounted bearingly on the axle 108. Accordingly, the auxiliary gear 24' is able to rotate on the axle 108 without any frictional engagement with the ring shield 32', the only contact being at the axle. This  
 30 structural improvement results in the elimination of frictional effects occasioned

by the former use of the upper and inner guide surfaces, both of which being now obviated.

To those skilled in the art to which this invention appertains, the above described preferred embodiment may be subject to change or  
5 modification. Such change or modification can be carried out without departing from the scope of the invention, which is intended to be limited only by the scope of the appended claims.